

# **MISSOURI DEPARTMENT OF NATURAL RESOURCES**



## **CLEANUP LEVELS FOR MISSOURI (CALM) Appendix D**

### **Tier 3 Cleanup Process**

**Division of Air and Land Protection  
Hazardous Waste Program**

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# **CLEANUP LEVELS FOR MISSOURI (CALM)**

## **APPENDIX D - TIER 3 PROCESS**

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## 1. INTRODUCTION

Tier 3 is intended to provide a more flexible approach for determining site-specific cleanup levels by allowing the use of data and models not used or allowed in Tiers 1 and 2. Remediation goals determined in Tier 3 are intended to be as protective of human health and the environment as those in Tiers 1 and 2. Tier 3 simply provides maximum flexibility in the use of site-specific data, risk assessment, contaminant transport modeling, and in the subsequent calculation of remediation goals.

### 1.1 Tier 3 Evaluation

#### A. When Tier 3 Is Appropriate

These are examples of site conditions which may warrant evaluation using Tier 3. Not all of these conditions need be present at the same site to support movement to Tier 3. Also, the presence of one or more of these conditions is in itself not necessarily sufficient to justify a Tier 3 evaluation.

- Complex geology and/or hydrogeology;
- Multiple contaminants are present, and additive or synergistic toxicity effects may be important;
- Development of alternate groundwater cleanup targets (GTARC) is warranted
- A quantitative ecological risk assessment is warranted;
- Remediation to Tier 1/Tier 2-derived cleanup levels is not feasible<sup>1</sup>; and
- Application of the models and formulas used to calculate Tier 1/Tier 2 cleanup levels do not adequately represent actual site conditions.

#### B. Features of a Tier 3 Evaluation

Determination of Tier 3 cleanup target concentrations for soil and groundwater may include, among other things, the activities listed in the text boxes below. Refer to Section 2 of this appendix for further discussion of these activities.

Examples of Tier 3 Evaluation Activities
<ul style="list-style-type: none"><li>▶ Modification of parameters not allowed under Tier 2;</li><li>▶ Use of models different from those used in Tiers 1 and 2;</li><li>▶ Analysis of human and ecological risks at the site using formal risk assessment and/or contaminant fate and transport models;</li></ul>



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<sup>1</sup> Feasibility will be evaluated by the department based on review of technical, engineering, and financial considerations. However, financial considerations will be weighted least.

**Examples of Tier 3 Evaluation Activities (cont.)**

- ▶ Use of toxicological information not used in Tiers 1 and 2, to include new data from the sources used for Tiers 1 and 2, or other sources not used in Tiers 1 and 2;
- ▶ Land use/exposure scenarios significantly different from those made for the A, B and C scenarios used in Tiers 1 and 2 (i.e. recreational parklands, wildlife preserves, etc.);
- ▶ Evaluation of groundwater remediation objectives which exceed the Tier 1/ Tier 2 GTARC values and;
- ▶ Use of a point of compliance at some distance from the source for groundwater remediation.

Other features specific to the site, the contaminants or the remediation may be considered in Tier 3 at the department's discretion.

## **1.2 Notification and Approval**

Requests for the use of Tier 3 must be submitted in writing to the department. The request should include:

**Requirements for Tier 3 Requests**

- ▶ Justification for not remediating the site to the applicable Tier 1 or Tier 2 cleanup level;
- ▶ Description of site features which are not addressed or not sufficiently addressed by evaluation under other tiers;
- ▶ Description of methods to be used in a Tier 3 evaluation (i.e. specific fate and transport or risk assessment models, list of default assumptions to be replaced with site-specific data, etc. (see Section 2.2)). The department recognizes that the final set of tools used in tier 3 may differ somewhat from those proposed at the outset. However, the user is encouraged to provide as much information as possible;
- ▶ Technical justification for the methods and/or models proposed and;
- ▶ Additional background information as appropriate.

The department must approve the final models and site-specific parameter values used as well as the remediation objectives determined using Tier 3 methods.

## **2. DETERMINING TIER 3 SOIL AND GROUNDWATER REMEDIATION OBJECTIVES**

While all site-specific parameters allowed to be modified in Tier 2 (Appendix C, Section 2) may also be modified in Tier 3, additional parameters may be modified in Tier 3 that were not allowed to be modified in Tier 2. In addition, the Tier 2 guidance recommending the use of actual site data where possible, rather than regional or generic values also apply to Tier 3. For



some parameters, however regional data is sufficient. For example, wind speed could be based on a regional average. All site-specific parameter values must be provided to and approved by the department.

## 2.1 Use of Alternate Risk Assessment and Contaminant Fate and Transport Models

### A. Guidance for the Use of Modeling

Before proposing the use of a model, the user should examine the physical processes of interest, and consider whether it is even practical to model them. For example, the physical processes involved in multiphase contaminant transport (presence of NAPL) and in contaminant transport through highly fractured subsurface environments (karst) are complex and poorly understood. Many models lack accuracy when confronted with the high degree of heterogeneity that these conditions present. Therefore, modeling options for these situations are severely limited.

All proposals to employ contaminant modeling must be accompanied by: justification for model selection (see criteria below), a plan for model verification, the calibration process and its goals, establishment of performance targets, data acquisition, and a sampling and monitoring plan.

#### Examples of Appropriate Uses for Contaminant Transport Modeling

- ▶ Assist in evaluation of the problem;
- ▶ Provide predictive spatial and/or temporal estimates of contaminant transport in order to assess the current or potential future risks at a site;
- ▶ Design and/or evaluate remediation strategies;
- ▶ Conceptualize and study physical and chemical transport processes and;
- ▶ Evaluate limitations in data and guide collection of new data.

### B. Criteria for the Selection of Models

Environmental modeling is an attempt to represent real-world physical processes by mathematical equations. The equations in Appendix A, which are used to calculate Tier 1 and 2 STARC values, are environmental models. They are, however, very simplified representations of the physical processes they model, and as such, they incorporate simplifying assumptions. There are hundreds of publicly and commercially available software packages for modeling environmental processes in addition to those used in CALM. Some of them are only slightly more sophisticated than the equations used in Appendix A, and others employ thousands of lines of computer code using advanced mathematical algorithms and statistical analyses.



Because the real world physical processes involved in the movement of contaminants in the environment are so varied and complex, there is no single model appropriate for all or even most contaminant transport problems. Predictive modeling results should not be viewed as fact or viewed as actual contaminant concentrations or contaminant locations. All modeling results must be verified with actual field monitoring data. The user must provide sufficient sampling locations and temporal data points from these sampling locations to validate the model predictions. The proposed number of sampling locations and frequency of monitoring will be evaluated by the department on a site-specific basis.

The department has identified a number of general criteria which it may use to evaluate proposed models. All models must be approved for use by the department.

Criteria For Selecting Models	
▶	Selection should be based on the model's ability to represent the specific physical and chemical processes of interest at the site;
▶	The model must have adequate documentation;
▶	The model must have undergone independent professional peer-review, validation studies, and sensitivity testing;
▶	The modeling code should be non-proprietary;
▶	The model's simplifying assumptions, both explicit and implicit, should be well documented, understood, and justifiable for the specific application proposed; and
▶	Adequate training of the model user and experience with the proposed model is necessary.



If the approved model is not one the department has available, the modeling software package and documentation must be purchased for the department for use in evaluating the participant's Tier 3 modeling reports. The cost of this purchase and staff time for training on the model will be passed along to the participant as a direct oversight expense as allowed for in 10 CSR 25-15.010. Alternately, the participant may choose to provide a licensed, working version of the modeling software (along with manual(s) and any pre- and post-processor software) to the department. The user should anticipate longer departmental review times for models not previously evaluated by the VCP and for models using more advanced and complex code.



### C. Models Previously Evaluated by DNR

The department has limited experience with several contaminant transport models. Some of these are listed below<sup>2</sup>. Most of these models were developed by or under contract to the EPA, and as such, they are generally well documented, peer reviewed, and supported, and have undergone validation and sensitivity studies. This list is only a fraction of the commercially available computer modeling programs. It is offered only as guidance. Since the department is somewhat familiar with these models, the user may anticipate a faster review time as compared with the models unfamiliar to the department. However, the department encourages the consideration of all applicable commercially available mathematical models which meet the criteria discussed on page D4 of this appendix. In some cases, none of the models listed below will be appropriate. For example, the use of these models to predict contaminant movement in a highly fractured limestone subsurface environment is not generally an appropriate use.

Model	Use
AT123-D	Groundwater movement and contaminant transport in the saturated zone.
BIOSCREEN	Natural attenuation in groundwater
MODFLOW and add-in modules for contaminant transport (MOC, MOC3D, MODPATH)	Groundwater movement and contaminant transport in the saturated zone.
GFLOW (groundwater modeling program only; no contaminant transport capability)	Groundwater movement
SESOIL	Vertical contaminant transport in the unsaturated zone, and contaminant movement from unsaturated zone to surface runoff.
MINTEQ	Aqueous equilibrium geochemistry
ISCST3	Contaminant transport in air

<sup>2</sup> Listing here should not be construed as a departmental sanctioning or recommendation of certain models or software products. Further, although these models have been evaluated by the department, they are not necessarily appropriate for use in all situations.





## D. Required Modeling Documentation

The following documentation is required when contaminant fate and transport modeling is used as part of a Tier 3 evaluation to help develop Tier 3 cleanup levels.

Required Modeling Documentation	
▶	The model name, version, and date;
▶	A detailed and clear formulation of the problem to be solved;
▶	A description of the fundamental equations used to represent the physical processes being modeled;
▶	A list of all assumptions, implicit and explicit, used in the model and justification for their use;
▶	Results of sensitivity and uncertainty analyses;
▶	Results from the validation of the model, including comparison of model results with laboratory and field data;
▶	A list of prior field applications of the model, particularly uses in similar physical settings;
▶	A list of all input data required by the model and justification for any manipulation of input data used in the analysis. All site-specific input data should be clearly identified;
▶	Characterization of the level of precision, accuracy, and degree and direction of uncertainty in the model results.

## 2.2 Other Exposure Pathways and Elimination of Pathways Considered in Tiers 1 and 2

The pathways chosen for Tiers 1 and 2 are considered the major pathways for most sites. However, numerous exposure pathways have been investigated and discussed in the literature. If alternate pathways are considered major routes of exposure at a particular site, they should be included in the risk assessment.

Tier 1/Tier 2 pathways can be eliminated from consideration at Tier 3. The criteria for pathway elimination are generally the same as discussed in Tier 2 (Appendix C, Section 2.4).

## 2.3 Alternate Toxicological Data

Alternate toxicological information not used in Tiers 1 and 2 may be used in Tier 3 calculations. Examples include new toxicological data from the approved sources listed in the references of this document, or from other sources not listed there. The use of any alternate toxicological data must be justified by the user, and approved by both MDNR and MDOH. In general, the data should come from sources known to be scientifically



rigorous, such as peer-reviewed journals.

## 2.4 Alternate Land Use/Exposure Scenarios

In some circumstances, the user may wish to propose alternate exposure parameters based on the fact that the site does not fit into any of the land use scenarios (A, B, or C) employed in Tiers 1 and 2. For example, a contaminated property intended for future use as a wildlife reserve may have different exposure parameters than those used for the Tier 1/Tier 2 scenarios.

Justification must be provided for modifying the basic exposure scenario parameters. All proposed modifications must be approved by MDNR.

Modifications and/or additions to institutional control requirements may be necessary to ensure future land use meets criteria used to determine the cleanup goals.

## 2.5 Alternate Groundwater Cleanup Levels

Alternate groundwater cleanup levels which exceed the Tier 1/Tier 2 GTARC values may be allowed in some instances, at the department's discretion, under the following conditions:

Criteria for the Use of Alternate Groundwater Cleanup Standards	
▶	Groundwater contamination has been minimized to the extent feasible by remediation. Feasibility will be evaluated by the department by consideration of technical, engineering, and financial limitations. We recognize that the cost of cleaning up is important. However, protection of human health and the environment is our primary concern and therefore must be given the highest priority;
▶	All current and potential future beneficial uses as described by Missouri's clean water laws and regulations must be maintained and protected. For example, contamination of a current or potential future drinking water source at levels above the Tier 1/Tier 2 GTARC values will require remediation to the Table B1 GTARC value;
▶	The proposed alternate GTARCs are protective of human health to a minimum cancer risk level of $10^{-5}$ , and a hazard index of 1 for noncarcinogenic contaminants, and are protective of ecological receptors; and
▶	Use of the proposed alternate GTARCs will not result in off-site migration of contaminants at levels above the Tier 1/Tier 2 GTARC values.



## 2.6 Distant Point of Compliance for Groundwater Remediation

The groundwater point of compliance (POC) is the location(s) on-site where the contaminants of concern must be demonstrated to be below the approved GTARC. In Tiers 1 and 2 the groundwater point of compliance is always at the source. In Tier 3, with department approval, the groundwater point of compliance may be set at a point distant from the contaminant source. This would allow for contaminant levels in groundwater above the Tier 1/Tier 2 GTARC values between the source and the point of compliance.

Although it is possible that the point of exposure (POE), where groundwater contaminants meet a potential receptor such as a drinking water source or surface water body, may be at some distance from the property in question, the department feels it is necessary to limit contamination above the GTARC levels to the property boundaries. There are several reasons for this. First, since groundwater is included in the definition of waters of the state, it is covered by the antidegradation policy described in the Water Quality Regulations (10 CSR 20-7-031). It is the department's policy, therefore, not to allow contaminant sources on VCP sites to migrate into groundwater off-site at levels above the state Water Quality Standards for groundwater, which have been used in the past at VCP sites and have been adopted as Tier 1/Tier 2 GTARCS in CALM.

Second, the VCP oversees cleanup of properties whose boundaries are specifically defined upon entry into the program. In CALM, the department is allowing more flexibility than in the past to address groundwater contamination at VCP sites by allowing contaminant levels above the Water Quality Standards to remain in place, with the limitations described in this Appendix regarding notification of affected neighbors, prohibition of off-site migration, use of acceptable modeling methods, and continued monitoring. However, this flexibility applies only to the property enrolled in the VCP. Where off-site groundwater contamination is found to occur, the program requires, at minimum, that all affected adjacent property owners be notified. Off-site groundwater contamination (soil or groundwater) found to originate from a VCP site should in the department's opinion be addressed as part of the VCP cleanup, and the department will provide oversight for this off-site cleanup if requested. The VCP participant retains environmental liability (through applicable state and federal laws and regulations, and potential third party claims) for any off-site groundwater contamination they choose not to voluntarily address.

In conclusion, it would not be prudent for the department to "sanction" either current or potential future contamination of offsite property adjacent to a voluntary cleanup site. Therefore, the POC may not be located any farther from the source than the nearest downgradient human/ecological receptor or downgradient property line, whichever is closest. The criteria for using a distant POC are shown in the following text box.

**Criteria For Use of a Distant Groundwater Point of Compliance**

- ▶ Department approval is required, based on the following;
- ▶ The user must demonstrate that cleanup to the Tier 1/Tier 2 GTARC level is not feasible. Feasibility will be evaluated based on technical, engineering, and financial considerations, however financial considerations will be weighted least;
- ▶ The user must demonstrate to the department's satisfaction, using sampling data and contaminant modeling, that contaminants have not and will not migrate to or past the distant POC at levels above the approved GTARC values;
- ▶ The user must implement an approved groundwater monitoring plan. The plan must include a sufficient number of well locations, and an adequate frequency and length of monitoring to validate the model's predictions;
- ▶ It must be demonstrated that the presence of any contaminant levels on site which exceed the Tier 1/Tier 2 GTARC values do not pose a threat to current or potential future drinking water sources; and
- ▶ The user must follow all requirements for institutional controls as described in Appendix E.

If monitoring indicates that modeling predictions do not accurately represent actual site conditions such that human or ecological receptors may be threatened, the user should either: modify the RAP to address the discrepancies, modify the model and/or model inputs and re-analyze the problem, select a different, more appropriate model (with department approval), or propose new remedial measures to eliminate the exposure.

Actual or predicted future offsite (off-property) groundwater impacts will not be allowed. Any groundwater which is contaminated at levels above the Tier ½ GTARC must be contained within the site/property boundaries. Any off-site groundwater impacts that may have occurred prior to the site having been enrolled in the VCP must be reported to the affected adjacent property owner(s) (as required at all Tiers), and documentation of this notice should be provided to the department. The department encourages all VCP participants to characterize and remediate all off-site groundwater impacts, and will provide oversight for these activities as part of the VCP process.

**3. INSTITUTIONAL CONTROLS**

The requirements in Appendix E apply to cleanups in Tier 3.

**4. PUBLIC NOTICE AND PARTICIPATION REQUIREMENTS**

Please refer to Appendix E for further guidance on public participation and notice.